



National Aeronautics and
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MSFC-ICD-3085
Revision A
June 26, 2001

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

MICROGRAVITY SCIENCE GLOVEBOX (MSG)

INTERFACE CONTROL DOCUMENT

FOR

**TOWARD UNDERSTANDING
PORE FORMATION AND MOBILITY DURING
CONTROLLED DIRECTIONAL
SOLIDIFICATION IN A MICROGRAVITY
ENVIRONMENT INVESTIGATION
(PFMI)**

SYSTEMS ENGINEERING OFFICE / SD42

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(PFMI)**

PREPARED BY:

Doug Martin
Doug Martin
Hardware Development and Integration
Teledyne Brown Engineering

7/10/01
Date

APPROVED BY:

Donnie McCaghren
Donnie McCaghren
MSG Investigation Integration Manager UF2,
MSFC/SD46

7/10/01
Date

Lucinda Murphy
Lucinda Murphy
Systems Engineering, MSFC/SD42

7/17/01
Date

Linda Jeter
Linda Jeter
PFMI/SUBSA Manager, MSFC/SD44

7/12/01
Date

Brad T. Perkins
Brad Perkins
g-LIMIT Systems Engineer, MSFC/SD41

7/12/01
Date

Paul Luz
Paul Luz
PFMI/SUBSA System Engineer, MSFC/SD42

7-11-2001
Date

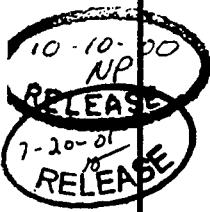
Release Date: ____ / ____ / ____		Marshall Space Flight Center SPECIFICATION/DOCUMENT CHANGE INSTRUCTION		Page 1 of 1
		Spec.Doc. No. MSFC-ICD-3085		Copy No.:
Change No./Date	SCN/DCN No./Date	CCBD No./Date	Replacement Page Instructions	
 CHG 1 REV A	N/A IRN 001	GB3-02-0004 GB00155 10/10/00 6/26/01 GB3-02-0010 and GB3-02-0010A	Basic Release Revision A retyped, reformatted and incorporates IRN 001 in lieu of document replacement pages. Pages Affected: ALL	

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1.0 Scope

This Interface Control Document (ICD) is the exclusive document that establishes the agreements between the Investigation Developer (ID) and the Microgravity Science Glovebox (MSG) Investigation Integration Team (IIT). The ICD identifies and establishes the Toward Understanding Pore Formation and Mobility During Controlled Directional Solidification in a Microgravity Environment Investigation (PFMI) physical/functional interfaces with the MSG facility. The PFMI interfaces and design must conform to the requirements and guidelines of the MSG Investigation Interface Requirements Document (IIRD), MSFC-RQMT-2888. This document contains the interface and resources allocated to PFMI for the performance of their science. Both sides of the interface are shown, and includes the mechanical, structural, electrical, avionics, environment, and functional interfaces. This document is under the control of the Microgravity Science Glovebox Integration (MSGI) Level III Configuration Control Board, and any changes or revisions shall be approved by the MSG Integration Manager (IM).

This ICD is the primary source for design implementation and documenting MSG specific interfaces of the MSG Investigation Interface Requirements Document, MSFC-RQMT-2888. This ICD controls the interfaces between the PFMI, the MSG, the GLovebox Integrated Microgravity Isolation Technology (g-LIMIT) and other elements and systems of the International Space Station (ISS). The ICD also contains the ground handling/integration requirements the PFMI needs during ground processing at Kennedy Space Center (KSC).

This ICD identifies and controls the following:

- Resources allocated to PFMI.
- Physical interfaces between PFMI to the MSG.
- KSC Integration Requirements
- Verification
- Physical interfaces between g-LIMIT and PFMI.

1.1 Use. Section 3.0 of this document contains the PFMI specific interface information, resource allocations and KSC requirements. Section 4.0 describes the verification activities and has an applicability matrix that provides traceability back to

the specific interface design requirements contained in the MSG IIRD, MSFC-RQMT-2888 which are applicable to the Investigation. The specific verification methods for each IIRD interface design are contained in the Investigation Applicability Matrix. PFMI will be responsible for providing the specific Investigation interface information in Section 3.0 for each applicable interface as well as identifying all applicable IIRD requirements in MSFC-RQMT-2888. Any deviations/exceptions to the requirements must be approved by the MSG IIT. PFMI will be responsible for providing any analysis or documentation required to evaluate and disposition the identified exception to the IIRD.

1.2 Experiment Description. Toward Understanding Pore Formation and Mobility During Controlled Directional Solidification in a Microgravity Environment Investigation will promote understanding of detrimental porosity formation and mobility during controlled directional solidification processing in a microgravity environment. The objective is to improve the production of uniform composites. The investigation will be performed in a custom-built furnace that will allow the investigator to grow succinonitrile (SCN) crystals in a microgravity environment. Video cameras will be used to directly observe and record the generation and mobility of any pores or bubbles that develop during the directional solidification process.

The PFMI consists of the following hardware:

A thermal chamber which contains the heating and cooling gradient stage mounted on a translating table, an interchangeable sample system, two temperature-controlled hot zones and one thermoelectric cold zone, and two stepper motors for [1] translation of the thermal gradient stage and [2] video camera panning with zoom focus. The thermal chamber will be mounted to the g-LIMIT Payload Mounting Structure (PMS) via a PFMI supplied interface plate. The g-LIMIT isolator/PIP assembly will attach to the Work Volume (WV) coldplate.

Two macro lens assemblies are provided for flexible visual observation perpendicular to the transparent sample container. The lens systems attach to the Cohu 3812 cameras that are in turn mounted to translation stages adjacent to the thermal chamber.

The Data Acquisition Pad (DaqPad) provides data acquisition and signal conditioning functions for the sample temperature probes. The DaqPad is located inside the MSG WV and is attached to the bottom of the Process Control Module (PCM). The DaqPad acquires the sample temperature readings and routes the data to the PCM for overlay on the camera images.

The PCM maintains the thermal chamber heater and cooler setpoints, overlays text and thermal data onto the video camera images, and routes the modified images via video cable connections to the MSG video subsystem. The MSG downlinks the video images to the ground during acquisition of signal while the Video Cassette Recorder (VCRs) simultaneously record the images to tape on board the ISS. The PCM receives and passes through all RS232 motor translation system commands from the MLC to the thermal chamber. The firmware temperature controller units receive remote setpoint adjustment via RS232 serial link to the MLC. The PCM is mounted via threaded fasteners to the top right corner of the MSG WV.

The PFMI samples consist of cylindrical glass or quartz tubes with an inner diameter of 10.0 mm, 1.5 mm wall thickness, and approximate length of 31 cm. The sample materials will include some samples of pure SCN and some samples of SCN and 1% water. Twelve PFMI transparent sample assemblies are requested for the UF-2 mission, with three spare samples available as replacements. The samples must be kept at a temperature between 2°C and 35°C.

PFMI will utilize the MSG's video monitors, VCRs and MLC. The MLC and monitor will be located outside MSG's work volume in the crew cabin.

2.0 APPLICABLE DOCUMENTS

The reference documents cited in this document are provided by the MSG Project Office. The specified technical requirements listed in the body of this document must be met whether or not the source document is listed in this section. Unless otherwise specified, the referenced document latest revision level applies.

MSFC-RQMT-2888	MSG Investigation Interface Requirement Document
MSFC-ICD-3086	MSG ICD for SUBSA

3.0 INVESTIGATION INTERFACE AND RESOURCE ALLOCATIONS

3.1 Mechanical Interfaces and Stowage Resource Allocation. This section defines the structural interfaces PFMI requires while operating inside the MSG and the stowage resources and support equipment required for on-orbit operations and launch.

3.1.1 Stowage Resource Allocation. The total control mass allocation for the PFMI hardware is 123.2 lbs. (56 kg.). The total control volume allocation for the PFMI hardware is one Middeck Locker (0.056m^3) and one double Middeck Locker Equivalent (0.112 m^3).

The stowage items for PFMI are listed in Table I. The PFMI hardware items to be stowed are shown in Figure 1, the shared hardware items are shown in Figures 3 and 4 in the SUBSA ICD, MSFC-ICD-3086. The PFMI samples can be stowed indefinitely as long as the temperature is keep between 2°C and 35°C. PFMI samples will be loaded at L-8 days in the middeck. Early access is required for the samples within R+48 hours for return flight.

3.1.2 Hardware Responsibility. The specific items to be supplied for PFMI are listed in Table I. The MSG Outfitting Equipment to be supplied by the IM to PFMI during ISS operations is listed in Table II. Lab Support Equipment that will be used by the investigations during ISS operation is listed in Table III. Microgravity Measurement/Isolation equipment to be used during ISS operations is listed in Table IV.

Table I. PFMI Supplied Hardware

Nomenclature	Part Number	Dimensions (cm)	Weight (kg)	Qty	Notes
PFMI THERMAL CHAMBER	5410002-FLT.M01.00.00-00-00	L: 47.6 W: 25.0 H: 36.3 D:	21.1	1	Cameras mounted to thermal chamber on orbit
PFMI SAMPLE BOX ASSEMBLY	5410002-FLT.M02.00.00-00-00	L: 44.5 W: 30.5 H: 24.1 D:	20.4	1	Keep Temp. between 2°C to 35°C. Do not use stowage tray in MDL. Contains 12 samples, Three Spares
Process Control Module (PCM)	5410002-FLT.M05.00.00-00-00	L:28.6 W: 26.7 H: 36.7 D:	8.4	1	Shared hardware (H/W) with SUBSA
DaqPad	5410002-FLT.M06.00.00-00-00	L:26.7 W: 15.2 H: 4.0 D: See notes	1.2	1	Shared H/W with SUBSA Pigtail cable attached is 76.2 cm long
PFMI Clean-up Kit	5410002-FLT.M07.02.00-00-00	L: 15.2 W: 15.2 H: 15.2 D:	2.3	1	
COHU Camera	5410002-FLT.M04.00.00-00-00	L: 18.6 W: 6.4 H: 8.3 D: See notes	0.9	2	Shared H/W with SUBSA (One). Camera + Lens and cable attached is 88.9 cm long.
PFMI Software CD	5410002-FLT.M07.00.00-00-00	L: 14.3 W: 1.0 H: 14.3 D:	0.01	1	Application Software for MLC
1G Optical Disk	5410002-FLT.M07.01.00-00-00	L: W: H: D:	0.001	2	For archival of PFMI & SUBSA science data (MSG provided)
PFMI W101 Pwr In Cable	5410002-FLT.M03.01.00-00-00	L: 77.5 W: H: D:0.63	0.2	1	
PFMI W202 Comm Data	5410002-FLT.M03.02.00-00-00	L: 61.2 H: D: 0.63	0.4	1	Shared H/W with SUBSA
PFMI W305 PCM Video Out	5410002-FLT.M03.03.00-00-00	L: 61.0 H: D:0.63	0.2	1	Shared H/W with SUBSA

Table I. PFMI Supplied Hardware Cont.

Nomenclature	Part Number	Dimensions (cm)	Weight (kg)	Qty	Notes
PFMI W201 Exp. Data	5410002-FLT.M03.06.00-00-00	L: 61.2 H: D: 1.72	0.2	1	
PFMI W303 PCM Video In	5410002-FLT.M03.04.00-00-00	L: 190.5 H: D: 0.76	0.3	1	
PFMI W102 PCM Pwr Out	5410002-FLT.M03.07.00-00-00	L: 218.04 H: D: 0.63	0.4	1	
PFMI W204 Thermal Chamber Data	5410002-FLT.M03.11.00-00-00	L: 101.0 H: D: 0.96	0.7	1	
PFMI W103 Thermal Chamber Pwr	5410002-FLT.M03.10.00-00-00	L: 91.4 W: H: D: 0.63	0.7	1	
PFMI Interface Plate	5410002-FLT.M00.00.01-00-00	L: 40.2 W: 34.93 H: 0.95 D:	3.2	1	
PFMI TAPE CASE (1,2,3)	96M53035	L: 29.0 W: 24.0 H: 10.0 D:	1.4	3	Each contains 20 8mm tapes (MSG provided)
1 G Optical disk	5410002-FLT.M07.01.00-00-00	L: W: H: D:	0.001	3	For g-LIMIT data stowage (MSG provided)
PFMI Tool	5410002-FLT.M07.03.00-00-00	L: TBD W: H: D:	0.15	1	Allen wrench
Pass thru cable #1	5410002-FLT.M03.13.00-00-00	L: 30.5 W: H: D: 0.63	0.28	1	g-LIMIT pass thru cable
Pass thru cable #2	5410002-FLT.M03.14.00-00-00	L: 30.5 W: H: D: 0.63	0.30	1	g-LIMIT pass thru cable
Pass thru cable #3	5410002-FLT.M03.15.00-00-00	L: 30.5 W: H: D: 0.63	0.27	1	g-LIMIT pass thru cable
Pass thru cable #4	5410002-FLT.M03.16.00-00-00	L: 30.5 W: H: D: 0.63	0.26	1	g-LIMIT pass thru cable

Table I. PFMI Supplied Hardware Cont.

Nomenclature	Part Number	Dimensions (cm)	Weight (kg)	Qty	Notes
Total		0.105 m ³ 3.69 ft ³	56.5 kg 124.5 lbs	25	Shared H/W not included in totals.
Control		0.168 m ³	56 kg 123.2 lbs		1 middeck 1 double MLE

Table II. MSG Supplied Outfitting Equipment

Nomenclature	Description	Qty	Notes
MLC	Laptop Computer, PCMCIA Cards, Harddrive, CD, Floppy	1	
MSG-W201 RS232 cable	RS232Cable to MSG J706	1	
MSG-W203 E-NET External cable	Ethernet Cable to MSG J46	1	
MSG-W202 1553B cable	1553B Cable to MSG Support Panel A&B	2	
MSG-W206 Parallel Port cable	Parallel cable	1	
MSG-W101 28Vdc Pwr Supply cable	MSG 28 Volt to 28V Power Brick	1	
MSG-W102 Pwr cable	MSG 28 Volt Power Brick to MLC	1	
MSG W104 120Vdc T Pwr	120V Pigtail Cable	1	
MSG Blank Glove Ring Assembly	6" Glove port plug	1	
2" Data Feedthrough	2" feedthrough for WV	1	
Video Monitor	Sony	2	

Table II. MSG Supplied Outfitting Equipment Cont.

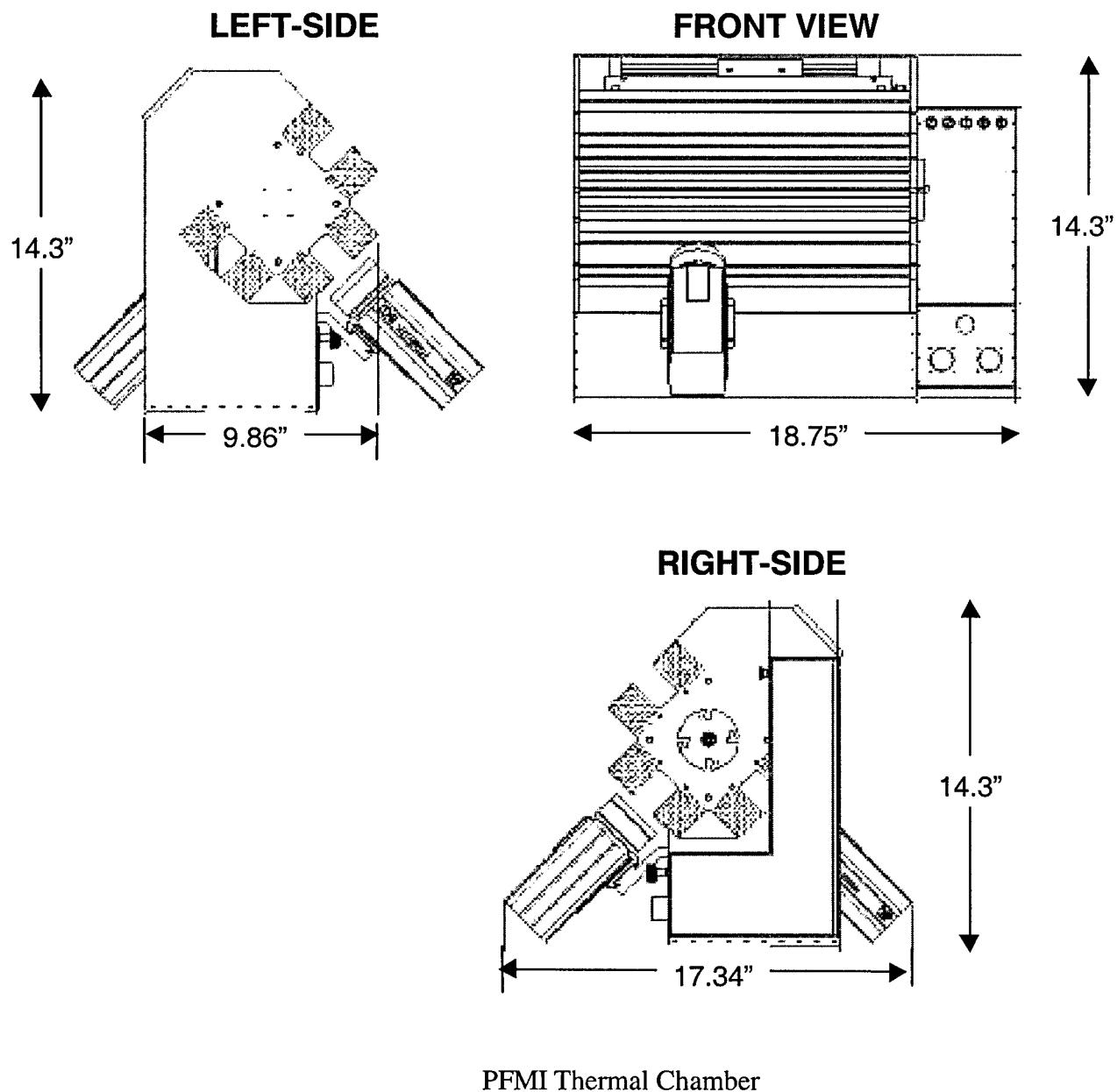
Nomenclature	Description	Qty	Notes
MSG Microphone Footswitch		1	
MLC 28Vdc POWER SUPPLY		1	MLC OPS
MSG Video Touch Pad		1	
MSG Tissues		1 box	
MSG Soft Stowage Bag		As required	
MSG Video Multipurpose Arm		2	
MSG Threaded Fastener Accessory Bag		As required	
MSG Velcro Cable Ties		As required	
MSG W301 Video Extension cable		1	
MLC Multipurpose Mount		1	
MLC Multipurpose Arm		1	
MLC 1553B PC Card		1	
MLC E-NET PC Card		1	
MSG 100mm Bungee Cord		As required	

Table III. Lab Support Equipment

Nomenclature	Description	Qty	Notes
35mm camera		1	Purpose: PR photos of hardware setup and installation.

Table IV. Microgravity Measurement Equipment

Nomenclature	Description	Qty	Notes
g-LIMIT		1	
g-LIMIT W102 Cable	RS422 Data Cable	1	



Note: The cameras on the PFMI thermal chamber are stowed separately, and will be installed on orbit

Figure 1. PFMI Hardware Items

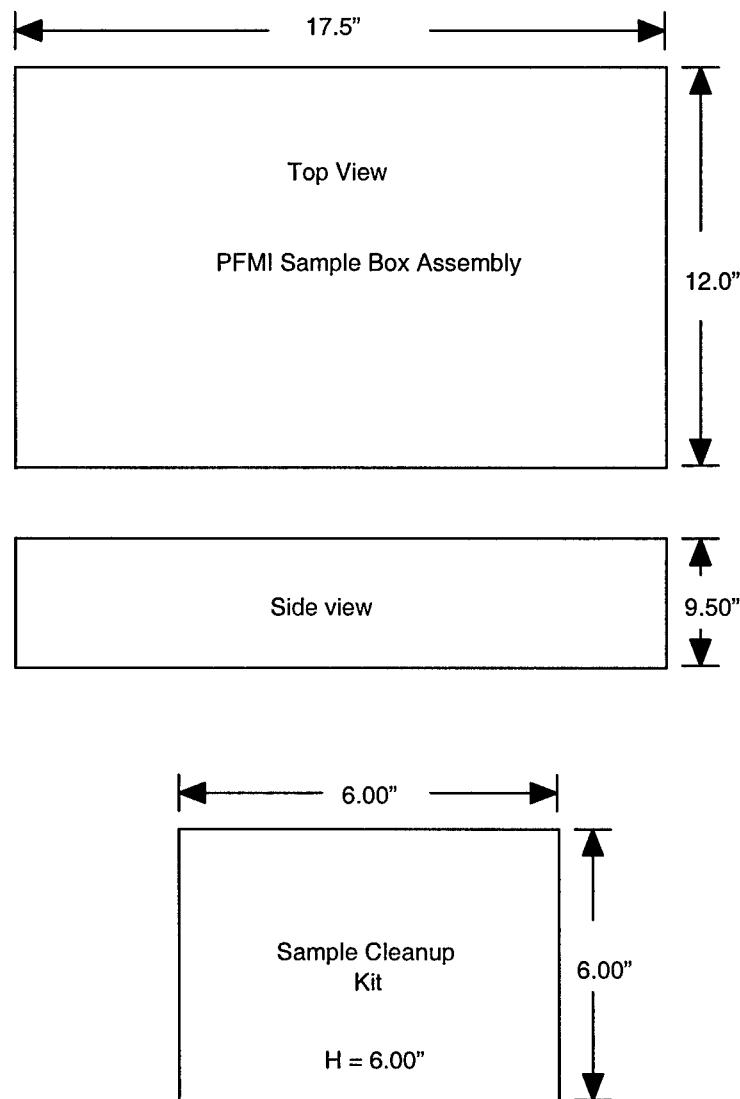
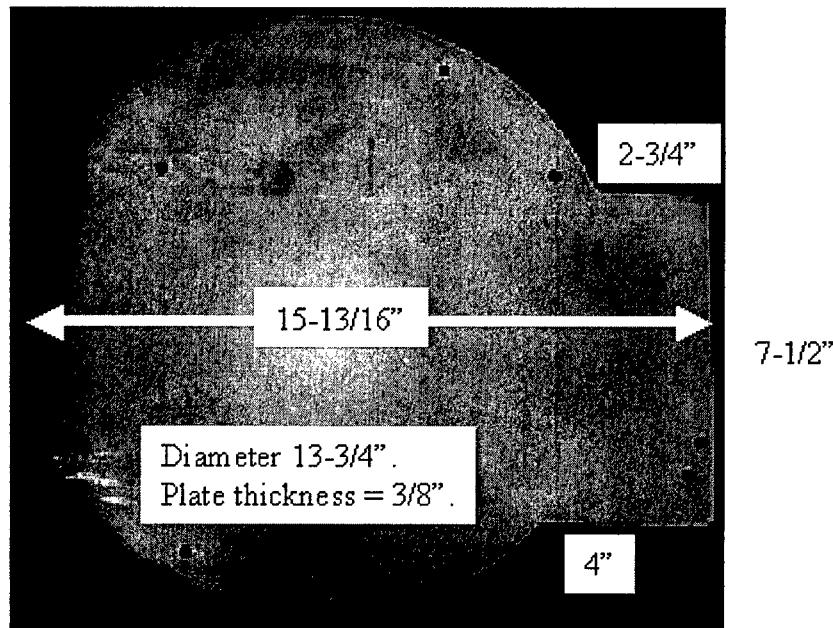


Figure 1. PFMI Hardware Items Cont.

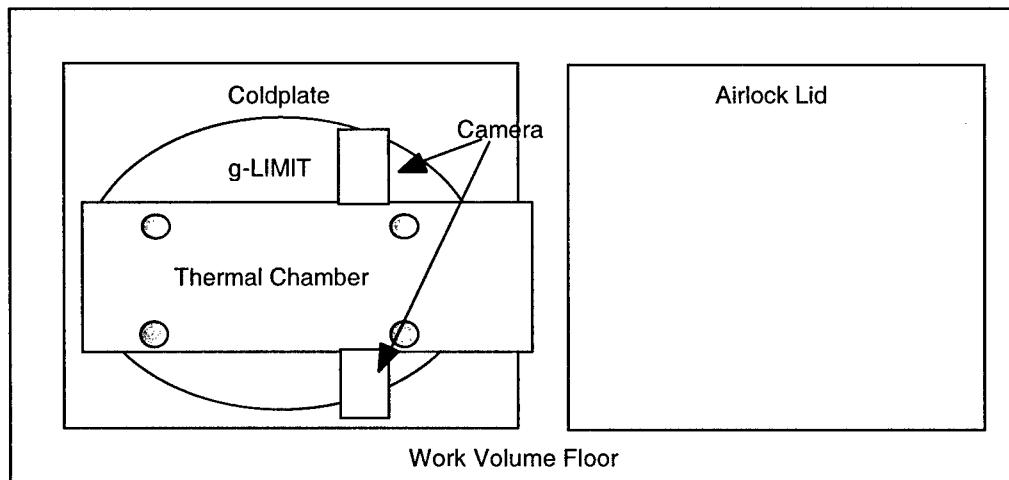
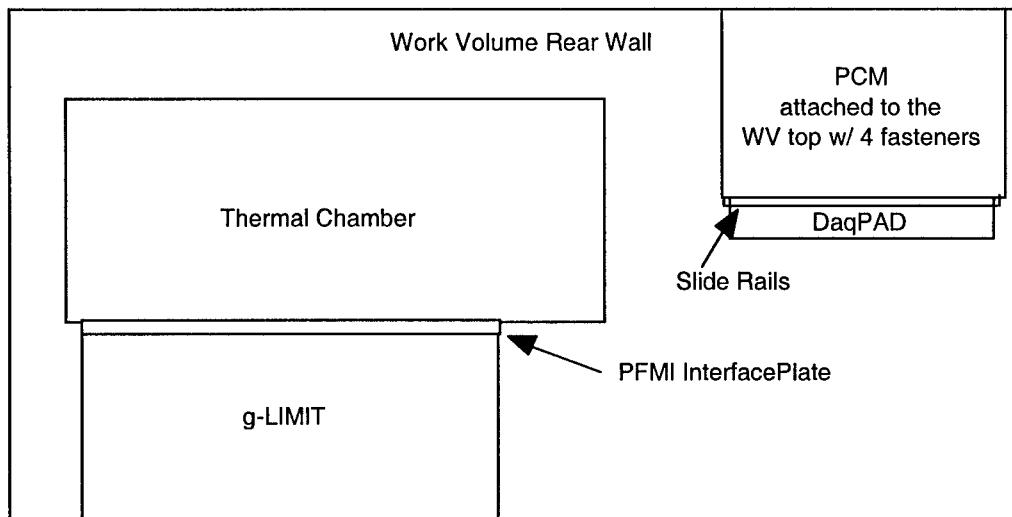


PFMI Interface Plate

Figure 1. PFMI Hardware Items Cont.

3.1.3 Structural/Mechanical Interface. This section identifies and defines the structural/mechanical interfaces between the PFMI, g-LIMIT and the MSG facility.

3.1.3.1 PFMI. The PFMI PCM is located in the upper right corner of the WV and the DaqPad will be mounted to the bottom of the PCM. The PFMI Thermal Chamber will mount using an interface plate to the g-LIMIT PMS, located on the MSG coldplate , using four threaded fasteners. The MLC and the video monitors will be located outside of the MSG Working Volume. Figure 2 shows the PFMI mounting provisions and the location of the hardware in the MSG work volume being used during on-orbit operations. Specific hardware mounting will be documented in the crew procedures.



◎ Fastener Locations

Figure 2. PFMI Mounting Provisions

3.2 Electrical Interfaces. This section identifies and defines the electrical power interfaces between PFMI, g-LIMIT and the MSG facility. A block diagram of the PFMI electrical interfaces is shown in Figure 3.

3.2.1 Electrical Power Interfaces. The PFMI interfaces with power conforming to the quality specified in sections 3.2.1 and 3.2.2 of the MSG IIRD MSFC-RMQT-2888.

The PFMI hardware will interface to the MSG primary and secondary power interfaces shown in Tables V and VI. The PFMI to g-LIMIT power interface is shown in Table VII.

3.2.2 Cabling Interfaces. The size of all wiring between PFMI and the MSG power source outlets shall be compatible with the rating of the power source circuit protection device and shall conform to the guidelines specified in section 3.2.2.5 and 3.2.3.1 of the MSG IIRD MSFC-RMQT-2888.

3.2.3 Grounding/Isolation. Grounding and Isolation of the PFMI hardware connected to the power source outlets will be in accordance with section 3.2.4.1 of the MSG IIRD MSFC-RMQT-2888.

3.2.4 Bonding. Bonding of the PFMI hardware to the MSG will be in accordance with section 3.2.4.2 of the MSG IIRD MSFC-RMQT-2888.

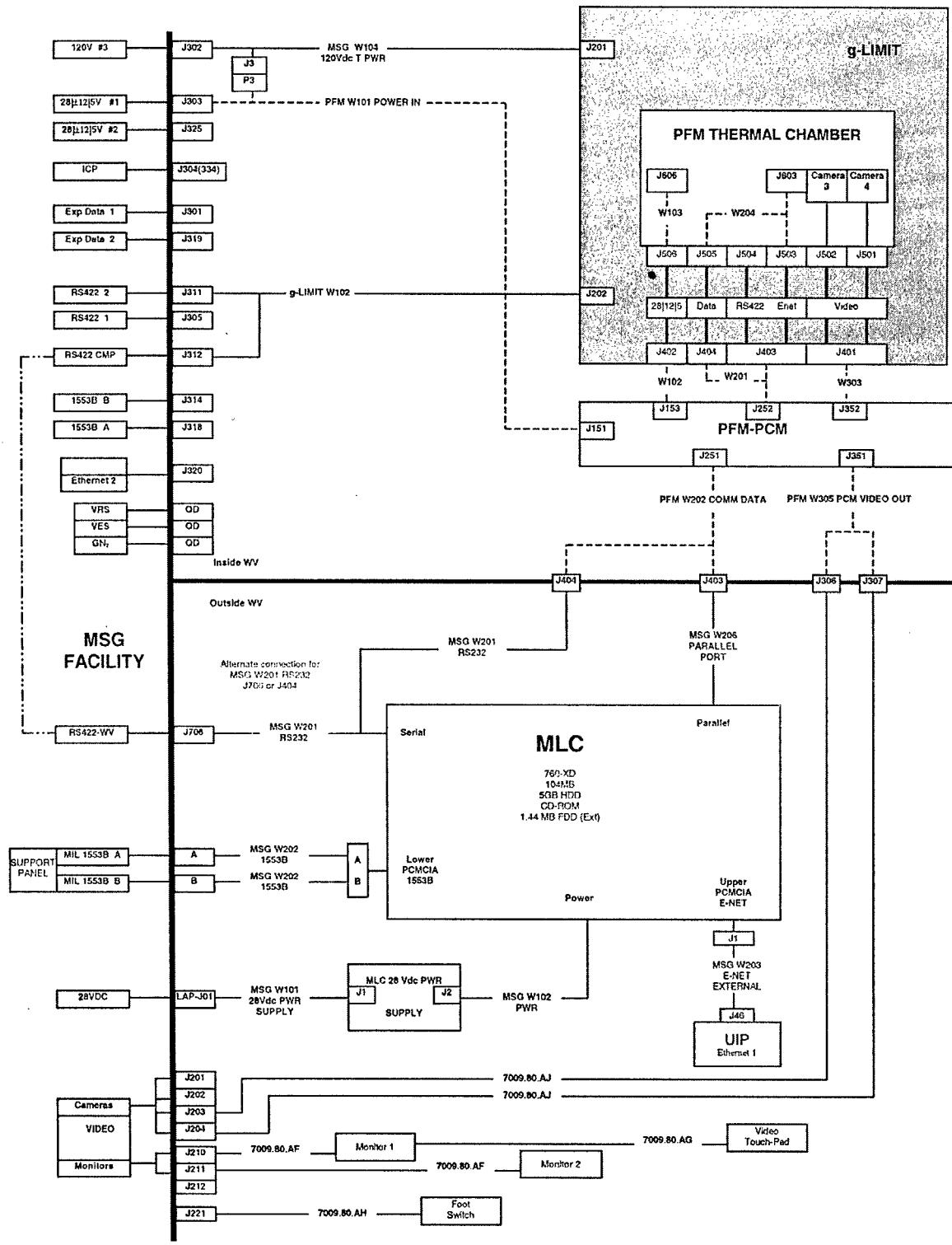


Figure 3. PFMI Electrical/Signal Interface Block Diagram

Table V. PFMI to MSG Primary Power Interface Pin Functions

PFMI Connector Type: MS27467E17F6PA Connector Marking: PFMI P3			Mating Connector Type: MS27656P17F6SA Connector Marking: MSG P3			
Pin No.	Pin Gage AWG	MSG Pin Functions (PFMI Pin Functions)	Volt Level	Max Load (PFMI Draw)	Signal Type	Destination
A	12	+120V DC Primary Power (same)	120V ± 4	8.3A (1.2A)	PWR	MSG/P3
B	12	RTN 120V DC Primary Power (same)				MSG/P3
C	12	Overall Shield (same)				MSG/P3
D	12	INHIBIT J302 (same)				MSG/P3
E	12	RTN for INHIBIT J302 (same)				MSG/P3
F	12	Chassis J302 (same)				MSG/J3

Note: Contacts D and E shall be bridged inside the investigation circuitry to assure proper operation of the inhibit.

Table VI. PFMI to MSG Secondary Power Interface Pin Functions

PFMI Connector Type: MS27467T21F11P Connector Marking: MSG P303			Mating Connector Type: MS27656P21F11S Connector Marking: MSG J303			
Pin No.	Pin Gage AWG	MSG Pin Functions (PFMI Pin Functions)	Volt Level	Max Load (PFMI Draw)	Signal Type	Destination
A	12	+28V Power Exp. Sec. (same)	28V ± 1	7A (2.5A peak) (1.2A steady state)	PWR	MSG/J303
B	12	RTN 28V Power Exp. Sec. (same)				MSG/J303
C	12	+12V Power Exp. Sec. (same)	+12V ± 1	2A (0.8A)	PWR	MSG/J303
D	12	-12V Power Exp. Sec.				Not Connected
E	12	RTN 12V Power Exp. Sec. (same)				MSG/J303
F	12	+5V Power Exp. Sec.				Not Connected
G	12	RTN 5V Power Exp. Sec.				Not Connected
H	12	INHIBIT J303 (same)				MSG/J303
J	12	Shield (same)				MSG/J303
K	12	RTN J303 (same)				MSG/J303
L	12	Chassis J303 (same)				MSG/J303

Note: Contacts H and K shall be bridged inside the investigation circuitry to assure proper operation of the inhibit.

Table VII. PFMI to g-LIMIT Secondary Power Interface Pin Functions

PFMI Connector Type: FGJ-2B-319-CLMD62 (LEMO) Connector Marking: g-LIMIT P402			Mating Connector Type: ECJ-2B-319-CLC (LEMO) Connector Marking: g-LIMIT J402			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Max Load	Signal Type	Destination
1	26	RTN ± 12V (RTN Inhibit for Sec. PWR)			Signal	
2	26	Chassis (same)				g-LIMIT/J402
3	26	RTN for INHIBIT (Chassis)				g-LIMIT/J402
4	26	Inhibit (Inhibit for Sec. PWR)	+5V		Signal	
5	24	RTN +5V (RTN 28VDC)				g-LIMIT/J402
6	24	+5V (+28 VDC)	+28V	2A	PWR	g-LIMIT/J402
8	24	+28V (ITO sample tube PWR 0 to 36VDC)	+0-36V	2.33A	PWR	g-LIMIT/J402
9	24	RTN + 28V (RTN ITO sample tube PWR)				g-LIMIT/J402
10	24	+28V (ITO sample tube PWR 0 to 36VDC)	+0-36V	2.33A	PWR	g-LIMIT/J402
11	24	RTN + 28V (RTN ITO sample tube PWR)				g-LIMIT/J402
12	26	+12V (+Inhibit for Primary PWR)			Signal	
13	26	-12V (Inhibit RTN Primary PWR)			Signal	
15	24	RTN +5V (RTN 28 VDC)				g-LIMIT/J402
16	24	+5V (+28VDC)	+28V	2A	PWR	g-LIMIT/J402
17	24	+28V (ITO sample tube PWR 0 to 36VDC)	+0-36V	2.33A	PWR	g-LIMIT/J402
18	24	RTN +28V (RTN ITO sample tube PWR)				g-LIMIT/J402

Table VII. PFMI to g-LIMIT Secondary Power Interface Pin Functions (Cont.)

PFMI Connector Type: MS27467T21F11P Connector Marking: g-LIMIT P506			Mating Connector Type: MS27656T21F11S Connector Marking: g-LIMIT J506			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Max Load	Signal Type	Destination
A	14	+28V DC (+0 to 36 VDC zone 1 PWR)	0-36V	7A	PWR	g-LIMIT/J506
B	14	RTN + 28V DC (RTN +0 to 36 V DC)				g-LIMIT/J506
C	14	+12V DC (RTN Inhibit for Primary)	+5V		Signal	
D	14	-12V DC (+Inhibit for Primary)	+5V		Signal	
E	14	RTN ±12 V DC (RTN Inhibit Sec.)				
F	14	+5V DC (+28V DC)	5V	4A	PWR	g-LIMIT/J506
G	14	RTN +5V DC (RTN +28V DC)				g-LIMIT/J506
H	14	INHIBIT J506 (+ Inhibit for Sec.)	5V		Signal	
J	14	Not Connected				Not Connected
K	14	RTN for Inhibit				Not Connected
L	14	Chassis J506 (same)				g-LIMIT/J506

3.2.5 Power Resource Allocation. Table VIII provides a listing of the power allocated to PFMI, including normal operating power and peak power. A power profile for PFMI is shown in Figure 4.

Table VIII. PFMI Power Allocation (Watts)

Item	Off Peak (1)	Peak (2)
PFMI	115 W	180 W
g-LIMIT	120 W	120 W

Notes:

(1) Off Peak - Normal operating power.
(2) Peak - The maximum level required.

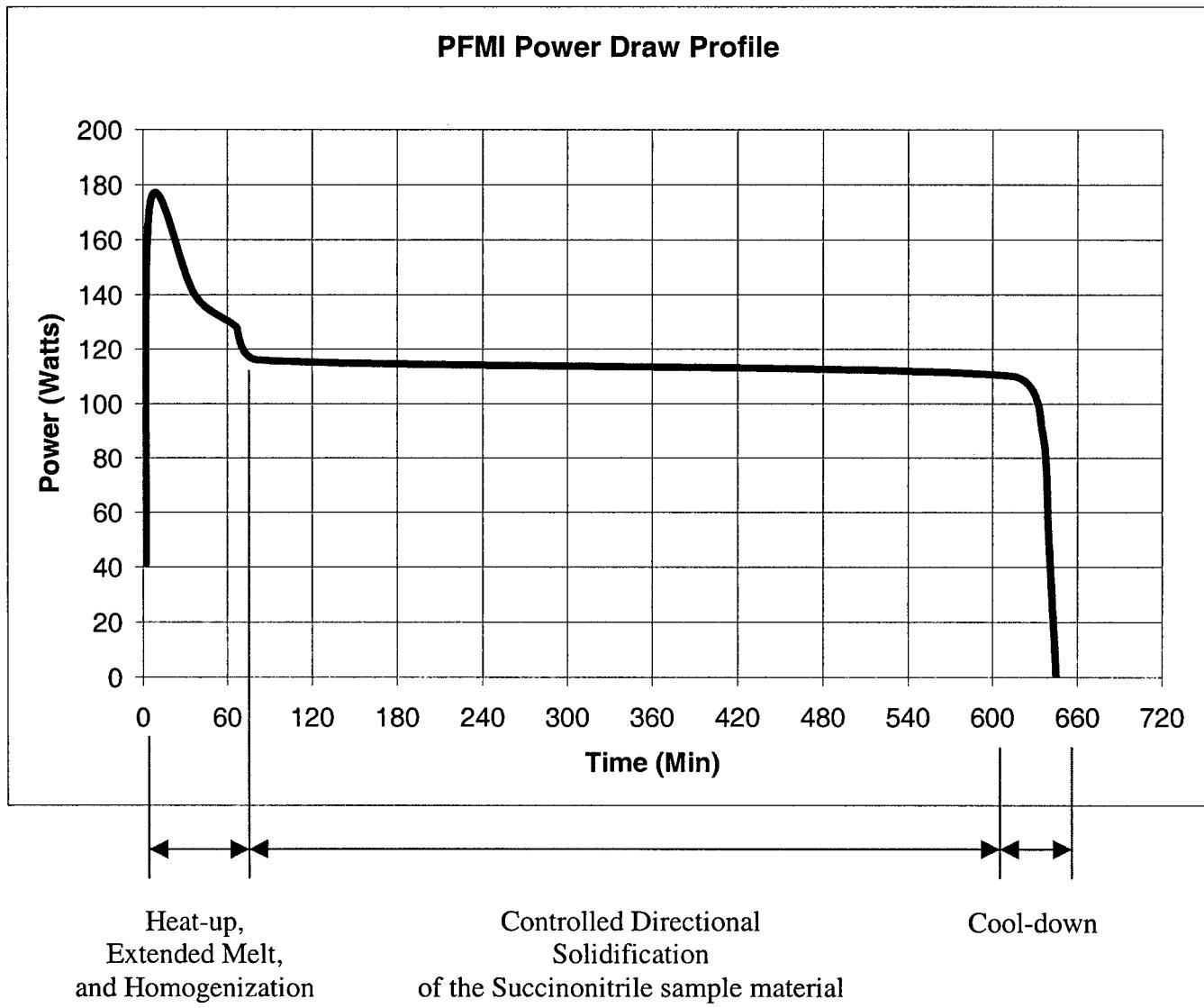


Figure 4. PFMI Power Profile

3.3 C&DH Interfaces. This section identifies and defines the Command & Data Handling (C&DH) System interfaces between PFMI and the MSG facility. A block diagram of the PFMI signal interfaces are shown in Figure 3.

The PFMI C&DH interfaces shall conform to the quality specified in section 3.3 of the MSG IIRD MSFC-RMQT-2888. The PFMI C&DH system interfaces are shown in Tables IX, Table X, Table XI and Table XII.

PFMI will use the MLC for data gathering and control, and two COHU cameras to capture sample images. The DaqPad receives the sample temperature data from the thermocouples and transfers the data to the PCM. The data, time and other status data is overlaid on the two sample video images by the PCM and sent to the MSG video recorders. These video signals will be downlinked to the ground and recorded simultaneously. The sample data will be archived on the MLC and downlinked after each run via the Ethernet. PFMI setpoints can be changed from the MLC or remotely commanded from the ground via the RS-232 interface. PFMI will provide Labview 6i application software to operate on the MLC.

3.3.1 Data Downlink Requirements.

PFMI will send the MLC Health and Status data at a rate of 54 Bytes/second. This Health and Status data will be included in the MSG facility Health and Status data and downlinked via the MIL-STD-1553 interface. PFMI requires post-run data dumps via the Ethernet of the PFMI science data and the g-LIMIT acceleration data. The estimated file size of PFMI data to be downlinked is 2.14 MB, this is assuming an 11 hour run. The file size of the g-LIMIT acceleration data is 126.72 MB. PFMI requires downlink of real-time video for sample observation, when available from ISS.

3.3.2 Uplink Requirements.

PFMI requires an uplink of 10 kBytes/sec to change setpoints in their application software on the MLC.

3.3.3 Post Mission Data Requirements.

The following post mission data shall be supplied to PFMI.

- 8mm science tapes
- 35mm photos
- 1G Optical disks with g-LIMIT acceleration data
- 1G Optical disk with science data

Table IX. PFMI to MSG Signal Cable Pin Functions

PFMI Connector Type: MS27467P9F35P Connector Marking: MSG P404			Mating Connector Type: MS27656P9F35S Connector Marking: MSG J404			
Pin No.	Pin Gage AWG	MSG Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	20	RX (TO MLC RS232 PIN 2)	± 15 VDC	6 ma	RS-232	MSG/J404
2	20	RTS (NOT USED)	± 15 VDC	6 ma	RS-232	Not Connected
3	20	RX GND (TO MLC RS232 Ground PIN 5)	0VDC	0 ma	RS-232	MSG/J404
4	20	TX+ (TO MLC RS232 PIN 3)				MSG/J404
5	20	CTX (NOT USED)				Not Connected
6	20	TX GND				Not Connected

Table IX. PFMI to MSG Signal Cable Pin Functions (Cont.)

PFMI Connector Type: NB6E18-32PN Connector Marking: PFMI J403			Mating Connector Type: NB5H18-32PSN Connector Marking: MSG J403			
Pin No.	Pin Gage AWG	MSG Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	20	Strobe (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
2	20	Bit 0 (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
3	20	Bit 1(SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
4	20	Bit 2 (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
5	20	Bit 3 (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
6	20	Bit 4 (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
7	20	Bit 5 (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
8	20	Bit 6 (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
9	20	Bit 7 (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
10	20	Ack (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
11	20	Bsy (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
12	20	Paper End (ERROR)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
13	20	Select In (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
14	20	Autofeed (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
15	20	Error (FAULT)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
16	20	Init (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
17	20	Select (SAME)	-0.5 to +5.5VDC	14 ma	IEEE1284	MSG J403
18	20	Ground (not used)				
19	20	Ground (SAME)	0VDC	0 ma	IEEE1284	MSG J403
20-25	20	Grounds (20 – 25 not used)				

Table X. PFMI to g-LIMIT Signal Cable Pin Functions

PFMI Connector Type: FGG-2B-319-CLC62 (LEMO) Connector Marking: g-LIMIT P403			Mating Connector Type: ECG-2B-319-CLM (LEMO) Connector Marking: g-LIMIT J403 (E-NET/RS-422)			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	26	Shield E1-TX (Motor 1 RS485 Shield)				g-LIMIT/J403
2	26	Shield E1-RX (Motor 2 RS485 Shield)				g-LIMIT/J403
3	26	E1-RX+ (RS485 B+ data to Motor 1)				g-LIMIT/J403
4	26	E2-TX+ (RS485 B+ data to Motor 2)				g-LIMIT/J403
5	26	Shield E2-TX (SSR 4 RTN)				g-LIMIT/J403
6	26	Shield E2-RX				Not Connected
7	26	E2-RX+ (+SSR 5 control signal)	5V	5mA		g-LIMIT/J403
8	26	RS422 TX+				Not Connected
9	26	Shield TX				Not Connected
10	26	Shield RX				Not Connected
11	26	RS422 RX+		100 ±7 Ohm*		Not Connected
12	26	E1 TX+ (RS485 GND to Motor 2)				g-LIMIT/J403
13	26	E1-TX- (RS485 GND to Motor 1)				g-LIMIT/J403
14	26	E1-RX- (RS485 A- data to Motor 1)				g-LIMIT/J403
15	26	E2-TX- (RS485 A- data to Motor 2)				g-LIMIT/J403
16	26	E2-RX- (SSR 5 RTN)				g-LIMIT/J403
17	26	RS422-TX-				Not Connected
18	26	RS422 RX-		100 ±7 Ohm*		Not Connected

* Measured across the pins

Table X. PFMI to g-LIMIT Signal Cable Pin Functions (Cont.)

PFMI Connector Type: FGG-3B-330-CLC82 (LEMO) Connector Marking: g-LIMIT P404			Mating Connector Type: ECG-3B-330-CLM (LEMO) Connector Marking: g-LIMIT J404 (I/O data)			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	26	Digital In Shield (RTD 1 shield)				g-LIMIT/J404
2	26	RTN Digital In (RTD 1 signal)			resistance	g-LIMIT/J404
3	26	Digital In 0 (RTD 1 RTN 1)				g-LIMIT/J404
4	26	Digital In 1 (RTD 1 RTN 2)				g-LIMIT/J404
5	26	Digital Out 0 (RTD 3 signal)			resistance	g-LIMIT/J404
6	26	Digital Out 1 (RTD 3 RTN)				g-LIMIT/J404
7	26	RTN Digital Out (+SSR 4 control signal)	5V DC	5 mA	control	g-LIMIT/J404
8	26	Digital Out Shield				Not Connected
9	26	Not Connected				
10	26	Analog 0+ (RTD 5 signal)			resistance	g-LIMIT/J404
11	26	Analog 0- (RTD 5 RTN)				g-LIMIT/J404
12	26	Analog Shield (SSR 3 RTN)				g-LIMIT/J404
13	26	Analog RTN (+SSR 3 control signal)	5V DC	5 mA	control	g-LIMIT/J404
14	26	Analog 1+ (RTD 6 signal)			resistance	g-LIMIT/J404
15	26	Analog 1- (RTD 6 RTN)				g-LIMIT/J404
16	26	Not Connected				
17	26	Not Connected				
18	26	Digital In 2 (RTD 2 signal)			resistance	g-LIMIT/J404
19	26	Digital In 3 (RTD 2 RTN)				g-LIMIT/J404
20	26	Digital Out 2 (RTD 4 signal)			resistance	g-LIMIT/J404
21	26	Digital Out 3 (RTD 4 RTN)				g-LIMIT/J404
22	26	Not Connected				
23	26	Analog 2+ (+SSR 1 control signal)	5V DC	5 mA	control	g-LIMIT/J404
24	26	Analog 2- (+SSR 1 RTN)				g-LIMIT/J404
25	26	Analog 3+ (+SSR 2 control signal)	5V DC	5 mA	control	g-LIMIT/J404
26	26	Analog 3- (+SSR 2 RTN)				g-LIMIT/J404

Table X. PFMI to g-LIMIT Signal Cable Pin Functions (Cont.)

PFMI Connector Type: D38999/26FG75P Connector Marking: g-LIMIT P503			Mating Connector Type: D38999/20FG75S Connector Marking: g-LIMIT J503 (Ethernet)			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
A-S	22	Shield E1-TX (Motor 1 shield)				g-LIMIT J503
A-C1	22	E1-TX+ (RS485 GND to Motor 2)				g-LIMIT J503
A-C2	22	E1-TX- (RS485 GND to Motor 1)				g-LIMIT J503
B-S	22	Shield E1-RX (Motor 2 shield)				g-LIMIT J503
B-C1	22	E1-RX+ (RS485 B+ to Motor 1)			RS485+	g-LIMIT J503
B-C2	22	E1-RX- (RS485 A- to Motor 1)			RS485-	g-LIMIT J503
C-S	22	Shield E2-TX (SSR4 RTN)				g-LIMIT J503
C-C1	22	E2-TX+ (RS485 B+ to Motor 2)			RS485+	g-LIMIT J503
C-C2	22	E2-TX- (RS485 A- to Motor 2)			RS485-	g-LIMIT J503
D-S	22	Shield E2-RX				Not Connected
D-C1	22	E2-RX+ (+SSR 5 control signal)	5V DC	5 mA	Control	g-LIMIT J503
D-C2	22	E2-RX- (SSR 5 RTN)				g-LIMIT J503

Table X. PFMI to g-LIMIT Signal Cable Pin Functions (Cont.)

PFMI Connector Type: MS27467T15F35PA Connector Marking: g-LIMIT P505			Mating Connector Type: MS27656T15F35SA Connector Marking: g-LIMIT J505 (I/O data)			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	26	Analog 0+ (RTD 5 signal)			resistance	g-LIMIT/J505
2	26	Analog 0- (RTD 5 RTN)				g-LIMIT/J505
3	26	Analog 1+ (RTD 6 signal)			resistance	g-LIMIT/J505
4	26	Analog 1- (RTD 6 RTN)				g-LIMIT/J505
5	26	Analog 2+ (+SSR 1 control signal)	5V DC	5 mA	control	g-LIMIT/J505
6	26	Analog 2- (SSR 1 RTN)				g-LIMIT/J505
7	26	Analog 3+ (+SSR 2 control signal)	5V DC	5 mA	control	g-LIMIT/J505
8	26	Analog 3- (SSR 2 RTN)				g-LIMIT/J505
9	26	Analog RTN (+SSR 3 control signal)	5V DC	5 mA	control	g-LIMIT/J505
10	26	Digital In 0 (RTD 1 RTN 1)				g-LIMIT/J505
11	26	Digital In 1 (RTD 1 RTN 2)				g-LIMIT/J505
12	26	Digital In 2 (RTD 2 signal)			resistance	g-LIMIT/J505
13	26	Digital In 3 (RTD 2 RTN)				g-LIMIT/J505
18	26	RTN Digital In (RTD 1 signal)			resistance	g-LIMIT/J505
19	26	Digital Out 0 (RTD 3 signal)			resistance	g-LIMIT/J505
20	26	Digital Out 1 (RTD 3 RTN)				g-LIMIT/J505
21	26	Digital Out 2 (RTD 4 signal)			resistance	g-LIMIT/J505
22	26	Digital Out 3 (RTD 4 RTN)				g-LIMIT/J505
27	26	RTN Digital Out (+SSR 4 control signal)	5V DC	5 mA	control	g-LIMIT/J505
33	26	Analog Shield (SSR 3 RTN)				g-LIMIT/J505
36	26	Dig. In Shield (RTD 1 shield)				g-LIMIT/J505
37	26	Digital Out Shield				Not Connected

Table XI. PFMI to MSG Video Connector Pin Functions

PFMI Connector Type: FGG-2B-319-CLCD62 (LEMO) Connector Marking: MSG P306 Video Feedthrough			Mating Connector Type: SGJ-2B-319-CLL-PV (LEMO) Connector Marking: MSG J306			
Pin No.	Pin Gage AWG	MSG Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	22	RTN (same)				MSG /J306
2	22	+ 12V In (Same)	+12V	TBD	PWR	MSG/J306
3	22	Not Connected				
4	TSP	RTN Comp. Video				Not Connected
5	TSP	Comp. Video				Not Connected
6	TSP	RTN Y (same)				MSG /J306
7	TSP	Y Out (same)		75 Ohm	Video	MSG /J306
8	TSP	RTN C				Not Connected
9	TSP	C Out				Not Connected
10	TSP	RTN Sync				Not Connected
11	TSP	Sync In				Not Connected
12	24	RTN				Not Connected
13	24	Not Connected				Not Connected
14	24	SD In				Not Connected
15	24	SD Out				Not Connected
16-19	24	Not Connected				

Table XI. PFMI to MSG Video Connector Pin Functions (Cont.)

PFMI Connector Type: FGG-2B-319-CLCD62 (LEMO) Connector Marking: MSG P307 Video Feedthrough			Mating Connector Type: SGJ-2B-319-CLL-PV (LEMO) Connector Marking: MSG J307			
Pin No.	Pin Gage AWG	MSG Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	22	RTN (same)				MSG /J307
2	22	+ 12V In (same)	+12V	TBD	PWR	MSG /J307
3	22	Not Connected				
4	TSP	RTN Comp. Video				Not Connected
5	TSP	Comp. Video				Not Connected
6	TSP	RTN Y (same)				MSG /J307
7	TSP	Y Out (same)		75 Ohm	Video	MSG /J307
8	TSP	RTN C				Not Connected
9	TSP	C Out				Not Connected
10	TSP	RTN Sync				Not Connected
11	TSP	Sync In				Not Connected
12	24	RTN				Not Connected
13	24	Not Connected				Not Connected
14	24	SD In				Not Connected
15	24	SD Out				Not Connected
16-19	24	Not Connected				

Table XII. PFMI to g-LIMIT Video Connector Pin Functions

PFMI Connector Type: FGG-3B-330-CLC82 (LEMO) Connector Marking: g-LIMIT P401			Mating Connector Type: ECG-3B-330-CLM (LEMO) Connector Marking: g-LIMIT J401			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1		Not Connected				
2	26	RTN COMP VIDEO/1				Not Connected
3	26	COMP VIDEO OUT/1				Not Connected
4	26	RTN Y/1 (same)				g-LIMIT J401
5	26	Y-OUT/1 (same)		75 Ohm	Video	g-LIMIT/J401
6	26	RTN C/1 (Shield)				g-LIMIT/J401
7	26	C-OUT/1 (To MLC RS232 Rec. pin 2)			signal	g-LIMIT/J401
8	26	RTN SYNC/1 (To MLC RS232 Tra. Pin 3)			signal	g-LIMIT/J401
9	26	SYNC-OUT/1 (To MLC RS232 GND pin 5)				g-LIMIT J401
10		Not Connected				
11	26	SYNC-OUT/2 (To MLC RS232 GND pin 5)				g-LIMIT J401
12	26	RTN SYNC/2 (To MLC RS232 Tra. Pin 3)			signal	g-LIMIT/J401
13	26	C-OUT/2 (To MLC RS232 Rec. pin 2)			signal	g-LIMIT/J401
14	26	RTN C/2 (Shield)				g-LIMIT/J401
15	26	Y-OUT/2 (same)		75 Ohm	Video	g-LIMIT/J401
16	26	RTN Y/2 (same)				g-LIMIT J401
17	26	COMP VIDEO OUT/2				Not Connected
18	26	RTN COMP VIDEO/2				Not Connected
19	26	RTN 12V IN/1 (same)				g-LIMIT J401
20	26	+12 VDC IN/1 (same)	+12V		PWR	g-LIMIT/J401
21	26	RTN 12V OUT/1 (Shield)				g-LIMIT/J401
22	26	+12V OUT/1				Not Connected
23	26	SD IN/1				Not Connected
24	26	SD OUT/1				Not Connected
25	26	SD OUT/2				Not Connected
26	26	SD IN/2				Not Connected
27	26	+12V OUT/2				Not Connected
28	26	RTN 12V OUT/2 (Shield)				g-LIMIT/J401

Table XII. PFMI to g-LIMIT Video Connector Pin Functions (Cont.)

PFMI Connector Type: FGG-3B-330-CLC82 (LEMO) Connector Marking: g-LIMIT P401			Mating Connector Type: ECG-3B-330-CLM (LEMO) Connector Marking: g-LIMIT J401			
Pin No.	Pin Gage AWG	MSG Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
29	26	+12 VDC IN/2 (same)	+12V		PWR	g-LIMIT J401
30	26	RTN 12V IN/2 (same)				g-LIMIT J401

Table XII. PFMI to g-LIMIT Video Connector Pin Functions (Cont.)

PFMI Connector Type: FHG-2B-319-CLCD62 (LEMO) Connector Marking: g-LIMIT P501			Mating Connector Type: ECG-2B-319-CLM (LEMO) Connector Marking: g-LIMIT J501			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	22	RTN 12V In (same)				g-LIMIT /J501
2	22	+ 12V In (same)	+12V		PWR	g-LIMIT /J501
3	22	Not Connected				
4	TSP	RTN Comp. Video				Not Connected
5	TSP	Comp. Video				Not Connected
6	TSP	RTN Y (same)				g-LIMIT /J501
7	TSP	Y Out (same)		75 Ohm	Video	g-LIMIT /J501
8	TSP	RTN C (Shield)				g-LIMIT /J501
9	TSP	C Out (To MLC RS232 Rec. pin 2)			RS232	g-LIMIT /J501
10	TSP	RTN Sync (To MLC RS232 Tran. Pin 3)			RS232	g-LIMIT /J501
11	TSP	Sync Out (To MLC RS323 GRD pin 5)				g-LIMIT /J501
12	24	RTN 12V (Shield)				g-LIMIT /J501
13	24	12V Remote				Not Connected
14	24	SD In				Not Connected
15	24	SD Out				Not Connected
16-19	24	Not Connected				

Table XII. PFMI to g-LIMIT Video Connector Pin Functions (Cont.)

PFMI Connector Type: FHG-2B-319- CLCD62 (LEMO) Connector Marking: g-LIMIT J502			Mating Connector Type: ECG-2B-319-CLM (LEMO) Connector Marking: g-LIMIT J502			
Pin No.	Pin Gage AWG	g-LIMIT Pin Functions (PFMI Pin Functions)	Volt Level	Load	Signal Type	Destination
1	22	RTN 12V In (same)				g-LIMIT /J502
2	22	+ 12V In (same)	+12V		PWR	g-LIMIT /J502
3	22	Not Connected				
4	TSP	RTN Comp. Video				Not Connected
5	TSP	Comp. Video				Not Connected
6	TSP	RTN Y (same)				g-LIMIT /J502
7	TSP	Y Out (same)		75 Ohm	Video	g-LIMIT /J502
8	TSP	RTN C (Shield)				g-LIMIT /J502
9	TSP	C Out (To MLC RS232 Rec. pin 2)			RS232	g-LIMIT /J502
10	TSP	RTN Sync (To MLC RS232 Tran. Pin 3)			RS232	g-LIMIT /J502
11	TSP	Sync Out (To MLC RS323 GRD pin 5)				g-LIMIT /J502
12	24	RTN 12V (Shield)				g-LIMIT /J502
13	24	12V Remote				Not Connected
14	24	SD In				Not Connected
15	24	SD Out				Not Connected
16-19	24	Not Connected				

3.4 Thermal Control Interface Requirements. This section identifies and defines the thermal/heat dissipation requirements between PFMI and the MSG facility. The interface and resources requested and allocated to PFMI are shown in Table XIII and XIV.

The thermal interfaces contained in this section are limited to flight phases. These include launch, ascent, on orbit, and descent, continuing through post landing cargo bay purge and stabilization.

3.4.1 Ascent/Descent. PFMI does not require resources during ascent/descent.

3.4.2 On-Orbit Thermal Characteristics. The heat generated by PFMI is shown in Table XIV, and gives a break down of the heat dissipation for each investigation hardware item.

3.5 Vacuum System Requirement.

3.5.1 Vacuum Exhaust System. N/A

3.5.2 Vacuum Resource System. N/A

3.6 Pressurized Gas Requirement.

3.6.1 Nitrogen Requirement. N/A

3.6.2 Pressurized Gas Bottles. N/A

Table XIII. Environmental Control Requirements

Investigation	Air	Coldplate	Vacuum Vent	Vacuum Resource	GN2
PFMI	X	N/A	N/A	N/A	N/A

Table XIV. PFMI Thermal Accommodations

Hardware Item	Nominal H/W Power Draw (W)		Coldplate Heat Dissipation (W)		Air Loop Heat Dissipation (W)		Cabin Air Heat Dissipation (W)	
	Nom	Max	Nom	Max	Nom	Max	Nom	Max
Thermal Chamber	67	124	N/A	N/A	67	124	N/A	N/A
PCM	37	44	N/A	N/A	37	44	N/A	N/A
DaqPad	4	4	N/A	N/A	4	4	N/A	N/A
Cameras (2)	7	7	N/A	N/A	7	7	N/A	N/A
g-LIMIT	120	120	110	110	10	10	N/A	N/A
MLC	45	45	N/A	N/A	N/A	N/A	45	45
Video Monitor (2)	38.4	38.4	N/A	N/A	N/A	N/A	38.4	38.4
28V Powerbrick	2	2	N/A	N/A	N/A	N/A	2	2
Total	320.4	384.4	110	110	125	189	85.4	85.4

3.7 Special Environment. This section is used to identify any special environmental requires the investigations have during on-orbit or launch phases of the increment.

3.7.1 Vibration. The PFMI is sensitive to microgravity vibrations on orbit, therefore the Thermal Chamber will require the use of g-LIMIT.

3.7.2 Stowage. The PFMI samples are thermally sensitive and must be keep between 2°C and 35°C. Samples will be loaded in the middeck at L-8 days. PFMI requires early access to samples within R+48 hours.

3.8 KSC Requirements. There are two categories of KSC inputs required for payloads which will be flown and operated on the ISS. These two categories are:

- 1) KSC support requirements (offline)
- 2) KSC technical requirements (online)

The following Tables identify the requirements PFMI will need during KSC processing.

Table XV: Investigation Support Requirements

Req. No.	Reqmt	Specifications	Qty	Comments
Offline Processing				
PFMI		Processing prior to turnover		
Online Processing				
PFMI		Online test with facility		
User Room Area				
PFMI		500 square feet (shared with SUBSA)		
GSE, Special Test Equipment (Investigation supplied)				
PFMI		Power Supplies, Video Calibration Sample, Thermal Calibration Sample, , 2 Laptops, printer, Standard Electrical Test Equipment, Data Logger, GSE Cables, Tools	Per PDL	
Electrical Power				
PFMI		110Vac outlet, 60 Hz, 15A	8	
Stowage Requirements (at KSC)				
PFMI		N/A		
Other				

Table XVI: Equipment Support Requirements

Req. No.	Reqmt	Specifications	Qty	Comments
KSC Administrative Support				
PFMI		Phone, Internet Access	2	
		Hand Cart	1	
		Storage Cabinet, work table, desk, chairs	Per PDL	
KSC GSE and Special Test Equipment				
		N/A		
Other				
		Nitrogen	1K bottle	99.999 purity
		Dry Air	1K bottle	99.999 purity

Table XVII: Chemical Support Requirements

Req. No.	Reqmt	Specifications	Qty	Comments
Chemicals				
PFMI		Ethyl Alcohol	0.5 gal.	
Fluids				
PFMI		Deionized water	5 gal.	

Table XVIII: Reusable and Expendable Supply Support Requirements

Req. No.	Reqmt	Specifications	Qty	Comments
Reusable and Expendable Supplies				
PFMI		Lint free cloths	Per PDL	
		Gloves	Per PDL	
		Clean room clothes	Per PDL	
Other				

Table XIX: General Services Support Requirements

Req. No.	Reqmt	Specifications	Qty	Comments
Communications (including OIS-D)				
		N/A		
Equipment and Container Storage				
		N/A		
Hazardous Disposal, Storage, and Handling				
		Alcohol		
Photographic and Video Support				
		N/A		
Technical Support				
		N/A		
Transportation / Shipping				
		Shipment of containers back to MSFC	Per PDL	
Other				

Table XX: KSC Technical Requirements

Requirement Subjects	Required?
Handling/Orientation Requirements	N/A
Orbiter Middeck Late Installation/Servicing Between L-72 hrs and L-24 hrs	N/A
Orbiter Middeck Late Installation/Servicing within a Specific Time Between L-24 hrs and L-18.5 hrs	N/A
Orbiter Middeck Early Runway Destow	N/A
Orbiter Middeck OPF/MDD Destow within R+48 hours	YES
Sample Loading	L-8 days Middeck
Sample Mixing	N/A
Launch Delay (Refurbishment/Replacement)	N/A

4.0 VERIFICATION

4.1 Purpose. The purpose of this ICD is to define and control the design of interfaces between the investigation hardware and the MSG facility based on the requirements in the MSG IIRD, MSFC-RQMT-2888. The Investigation Developer and IIT must mutually disposition (Applicable or Not Applicable) each IIRD paragraph and record that disposition in the Verification Applicability Matrix, Appendix B.

4.2 Verification Applicability Matrix. The PFMI Verification Applicability Matrix, Table XXI lists the MSG Interface and Safety Verification Requirements between MSG facility and PFMI and does not address the performance or science requirements of the PFMI hardware. The Applicability (A) or (N/A) and a schedule for data submittal of each hardware element will be developed on a case-by-case basis.

Definitions of Column Headings for Verification Requirements

Requirement Number	Identifies verification requirements by number and the item status is tracked by using this number.
Requirement Title	Identifies the requirement.
Safety Related	Identifies those items required to satisfy a Hazard control.
MSG IIRD Paragraph	Defines the interface being used and the verification activity required for use of that interface.
Verification Method(s)	Defines the method(s) required to perform the verification function.
Hardware Item(s)	Defines each hardware element (i.e. Exp. Control Box, Exp. Sample Container, etc.) and its applicability to the requirement.
Due Date	Defines the date that the verification package is due to the Investigation Integration Team.
Remarks	Defines the Verification Data Sheet number or if it is a PSRP/Safety requirement.

The Investigator Verification Applicability Matrix, identifies items relevant to each verification requirement and hardware element. The items identified are: the method(s) of verification, the relevant Verification Data Sheet, if safety related and whether the item is applicable (A) or not applicable (N/A). Acceptable methods of verification are denoted by: Analysis ("A"), Test ("T"), Inspection ("I"), and Demonstration ("D"). For a more detailed description of the methods, certifications and safety verification, see Section 4.0 and 5.0 of the MSG IIRD, MSFC-RQMT-2888.

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APPENDIX A
ACRONYMS & ABBREVIATIONS

APPENDIX A

A	Applicable
AWG	American Wire Gage
CCBD	Configuration Control Board Directive
C&DH	Command & Data Handling System
cm	Centimeter
CMD	Command
CMP	Control & Monitoring Panel
COC	Certification of Compliance
D	Demonstration
DaqPad	Data Acquisition Pad
DI	Deionized
DCN	Document Change Notice
FDD	Floppy Disk Drive
g-LIMIT	Glovebox Integrated Microgravity Isolation Technology
GND	Ground
H/W	Hardware
ICD	Interface Control Document
ICP	Internal Control Panel
ID	Investigation Developer
IIRD	Investigator Interface Requirements Document
IIT	Investigation Integration Team
IM	Integration Manager
ISS	International Space Station
KSC	Kennedy Space Center
L	Launch
MDL	Middeck Locker
MDP	Maximum Design Pressure
MLC	MSG Laptop Computer
MLE	Middeck Locker Equivalent
MSFC	Marshall Space Flight Center
MSG	Microgravity Science Glovebox
MSGI	Microgravity Science Glovebox Integration
N/A	Not Applicable
NRV	No Verification Required
OIS	Operational Intercommunication System
OPF	Orbiter Processing Facility
OPS	Operations
PCM	Process Control Module
PCMCIA	Personnel Computer Memory Card International Association

PFMI	Toward Understanding Pore Formation and Mobility During Controlled Directional Solidification in a Microgravity Environment Investigation
PIP	Power & Information Processor
PMS	Payload Mounting Structure
PSRP	Payload Safety Review Panel
PWR	Power
QD	Quick Disconnect
Qty	Quantity
RTN	Return
RX	Receive
SCN	Succinonitrile
SUBSA	Solidification Using A Baffle in Sealed Ampoules
TBD	To Be Determined
TBR	To Be Resolved
TX	Transmit
UF2	Utilization Flight Two
V	Volt
VCR	Video Cassette Recorder
Vdc	Voltage Direct Current
VDS	Verification Definition Sheet
VES	Vacuum Exhaust System
VRS	Vacuum Resource System
W	Watt
WV	Work Volume

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Appendix A
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APPENDIX B
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APPENDIX B
PFMI VERIFICATION MATRIX

TABLE XXI PFMI VERIFICATION MATRIX

MSG IIRD Reqmt. No.	Requirement Statement	Safety	Verif. Method(s)	Thermal Chamber	Cables	Sample Ampoules	Stowage Boxes	Software	Cameras	Due Date	PFMI Tool	Remarks/ IIT VDS #
3.1.1.1.c & d	Loads Requirements		A	A	N/A	A	N/A	N/A	A	N/A	L-8	"d" not applicable ST-001 & ST-002
3.1.1.2.a & b	Additional Requirements		A&T	A	A	A	A	N/A	A	A	L-8	ST-003 & ME-001
3.1.1.3	Attachment Provisions (fit check with facility)		T&I	A	A	N/A	N/A	N/A	A	N/A	L-20 & L-20	ME-046
3.1.2.1	Quasi-Steady Requirements		A or T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-20 & L-12	EN-005
3.1.2.2	Vibratory Requirements		A or T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-20 & L-12	EN-005
3.1.2.3	Transient Requirements		A or T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-20 & L-12	EN-005
3.1.3	Stowage (Weight & Volume)		ICD input	A	A	A	A	N/A	A	A	L-8	ME-001
3.2.1.a & b	Electrical Power Characteristics (Power Draw)		A & T	A	A	N/A	N/A	N/A	A	N/A	L-8	EL-006
3.2.1.1	Steady-State Voltage Characteristics		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-001
3.2.1.2.1	Ripple Voltage and Noise	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	EL-002
3.2.1.2.2	Ripple Voltage Spectrum	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	EL-002
3.2.1.3	Transient Voltages		A or T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-003
3.2.1.3.1.a & b	Fault Clearing and Protection		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-004
3.2.1.3.2	Non-Normal Voltage Range		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	Only applies to 120V EL-005
3.2.2.1.b, c, d	Primary Power Connector		I & D	N/A	A	N/A	N/A	N/A	N/A	N/A	L-8	EL-007
3.2.2.2.b, c, d	Secondary Power Connector		I & D	N/A	A	N/A	N/A	N/A	N/A	N/A	L-8	EL-007
3.2.2.3.a	Surge Current		A & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-010
3.2.2.4	Reverse Energy/Current		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-011
3.2.2.5.a & b	Circuit Protection Devices	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-012
3.2.2.6	Maximum Ripple Voltage Emissions		A & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	EL-015
3.2.2.7	Electrical Load-Stand Alone Stability		A	A	A	N/A	N/A	N/A	A	N/A	L-10	EL-016

Legend:

A – Analysis (when in verification method column), A – Applicable (when used in hardware column), D – Demonstrate, I – Inspection, N/A – Not Applicable
NVR – No verification required, PSRP – Payload Safety Review Panel, T – Test,

TABLE XXI PFMI VERIFICATION MATRIX

MSG IIRD Reqmt. No.	Requirement Statement	Safety	Verif Method(s)	Thermal Chamber	Cables	Sample Ampoules	Stowage Boxes	Software	Cameras	PFMI Tool	Due Date	Remarks/ IIT VDS #
3.2.3.1	Wire Derating	Yes	A	A	A	N/A	N/A	A	N/A	L-8	EL-017	
3.2.3.2	Loss of Power	Yes	T (PSRP)	A	N/A	A	N/A	N/A	A	N/A	L-8	Safety
3.2.4	Electromagnetic Compatibility	Yes	A & T	A	A	A	N/A	N/A	A	N/A	L-10	EL-020 N/A for PFMI samples
3.2.4.1.a – e thru 3.2.4.1.2.7	Electrical Grounding/Isolation	Yes	A & T	A	A	N/A	N/A	N/A	A	N/A	L-10	EL-020 & EL-021
3.2.4.2 thru 3.2.4.2.6.3.2	Electrical Bonding	Yes	T & I & A	A	A	N/A	N/A	N/A	A	N/A	L-10	EL-020 & EL-022
3.2.4.3.1.2.1.3	Shield Grounding Requirements		T & I & A	A	A	A	N/A	N/A	A	N/A	L-10	EL-021
3.2.4.3.1.2.4	Shields		A & I	N/A	A	N/A	N/A	N/A	N/A	N/A	L-10	EL-021
3.2.4.3.1.2.4.1	Terminations		A & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	EL-021
3.2.4.3.1.2.4.3	Grounding of Radio Frequency Circuit Shields		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	EL-021
3.2.4.3.1.2.4.4	Internal Equipment Shields		A	A	A	N/A	N/A	N/A	A	N/A	L-10	EL-021
3.2.4.3.1.2.4.5	Grounding		A	A	A	A	N/A	N/A	A	N/A	L-10	EL-021
3.2.4.4 thru 3.2.4.4.2.6	Electromagnetic Emission and Susceptibility Requirements	Yes	A & T	A	A	A	N/A	N/A	A	N/A	L-10	EL-020 N/A for PFMI samples
3.2.4.5	Electrostatic Discharge	Yes	A & T or T & I	A	A	A	N/A	N/A	A	N/A	L-10	EL-024
3.2.4.6	Alternating Current Magnetic Fields	Yes	A or T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	AC not available in WV EL-020
3.2.4.7	Direct Current Magnetic Fields	Yes	A & T	A	N/A	A	N/A	N/A	N/A	N/A	L-10	EL-020 N/A for PFMI samples
3.2.5.1	Mating/Demating of powered connectors	Yes	I (PSRP)	A	A	N/A	N/A	N/A	A	N/A	L-8	Safety
3.2.5.2	Safety-Critical Circuits Redundancy	Yes	A (PSRP)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	"Closed with HR approval" Safety
3.2.5.3.a	Power Switches/Controls	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-029
3.2.5.3.b	Power Switches/Controls	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-029
3.2.5.3.c	Power Switches/Controls	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-029

Legend:

A – Analysis (when in verification method column), A – Applicable (when used in hardware column), D – Demonstrate, I – Inspection, N/A – Not Applicable
NVR – No verification required, PSRP – Payload Safety Review Panel, T – Test,

TABLE XXI PFMI VERIFICATION MATRIX

MSG IIRD Reqmt. No.	Requirement Statement	Safety	Verif. Method(s)	Thermal Chamber	Cables	Sample Ampoules	Stowage Boxes	Software	Cameras	Due Date	PFMI Tool	Remarks/ IIT VDS #
3.2.5.4.a - g	Ground Fault Circuit Interrupters	Yes	D,A & T	N/A	N/A	N/A	N/A	N/A	N/A	L-8		Not Portable No Outlets EL-030
3.3.1.1	Software		Per SSP-52050	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	
3.3.1.1.1	Software Protocol		T	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	CD-01
3.3.1.1.2	Byte and Bit Order		I	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	CD-01
3.3.1.1.3	ESTEC Data Link Format		I	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	CD-01
3.3.1.1.4	Command Acknowledge & Log Messages		I	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	CD-02
3.3.1.1.5	Commanding		T	A	A	N/A	N/A	A	A	N/A	L-8	CD-02
3.3.1.1.6	Health and Status		T	A	A	A	N/A	A	N/A	N/A	L-8	CD-02
3.3.1.1.7	Caution and Warning		T	A	A	A	N/A	A	N/A	N/A	L-8	CD-02
3.3.1.1.8	File Transfer		T	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	CD-02
3.3.1.1.9	Illegal Commands		T	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	CD-02
3.3.3.1.b	RS-422 Connector/Pin Assignments		D & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-007
3.3.3.2	RS-422 Signal Characteristics		I & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	CD-01
3.3.3.3	RS-422 Cabling		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-033
3.3.4	I/O Signal Levels & Resolution		A & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	CD-03
3.3.4.1.b	I/O Connector/Pin Assignments		D & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-007
3.3.5.1	Ethernet Protocol		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	CD-10
3.3.5.1.1	Investigation Protocol on Ethernet		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	CD-10
3.3.5.1.2	Ethernet Address		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	CD-10
3.3.5.1.3	Ethernet Connectivity		I & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-8	CD-11

Legend:

A – Analysis (when in verification method column), A – Applicable (when used in hardware column), D – Demonstrate, I – Inspection, N/A – Not Applicable
 NVR – No verification required, PSRP – Payload Safety Review Panel, T – Test,

TABLE XXI PFMI VERIFICATION MATRIX

MSG IIRD Reqmt. No.	Requirement Statement	Safety	Verif. Method(s)	Thermal Chamber	Cables	Sample Ampoules	Stowage Boxes	Software	Cameras	Due Date	PFMI Tool	Remarks/ IIT VDS #
3.3.5.1.4	Ethernet Connector/Pin Assignments		I	N/A	N/A	N/A	N/A	N/A	N/A	L-8		EL-007
3.3.5.1.5	Ethernet Signal Characteristics		I & T	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-8		CD-12
3.3.5.1.6	Ethernet Cable Characteristics		D & I	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-8		CD-12
3.3.5.1.6.1	Insertion Loss		T	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-8		CD-12
3.3.5.1.6.2	Differential Characteristic Impedance		T	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-8		CD-12
3.3.5.1.6.3	Medium Time Jitter		T	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-8		CD-12
3.3.6	MSG Laptop Computer Protocol		T	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	CD-07
3.3.6.1.1	RS-232C Data Port		I & T	N/A	A	N/A	N/A	N/A	N/A	N/A	L-8	CD-07
3.3.6.1.2	Parallel Port		I & T	N/A	A	N/A	N/A	N/A	N/A	N/A	L-8	CD-07
3.3.7	Video Interface Requirements		T & I, A or T	N/A	A	N/A	N/A	N/A	A	N/A	L-9	CD-08
3.4.1.1	WV Air Circulation System		A & T	A	N/A	N/A	N/A	N/A	A	N/A	L-8 & L-9	FD-002
3.4.1.2.1.a - f	Investigation Coldplate Mounting Requirements		A, T & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8 & L-9	FD-003
3.5.1.1.a - e	VES Physical Interface		D & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-014
3.5.1.2.a, b, c	VES Input Pressure Limit		A & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-015
3.5.1.3	VES Input Temperature Limit		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-016
3.5.1.4	VES Input Dewpoint Limit		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-017

Legend:

A – Analysis (when in verification method column), A – Applicable (when used in hardware column), D – Demonstrate, I – Inspection, N/A – Not Applicable
NVR – No verification required, PSRP – Payload Safety Review Panel, T – Test,

TABLE XXI PFMI VERIFICATION MATRIX

MSG IIRD Reqmt. No.	Requirement Statement	Safety	Verif. Method(s)	Thermal Chamber	Cables	Sample Ampoules	Stowage Boxes	Software	Cameras	PFMI Tool	Due Date	Remarks/ IIT VDS #
3.5.1.5.a - d	VES Acceptable Exhaust Gases		A or T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-20	FD-018
3.5.1.5.2.a - e	VES External Contamination Control		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-20	FD-019
3.5.1.5.3	VES Incompatible Gases		A & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-020
3.5.2.1.a - e	VRS Physical Interface		D & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-021
3.5.2.2.a, b, c	VRS Input Pressure Limit		A & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-022
3.5.2.3	VRS Through-Put Limit		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-023
3.6.1.1.a	Nitrogen Physical Interface		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-027
3.6.1.1.b	Nitrogen Leakage		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-027
3.6.1.2	Nitrogen Flow Control		T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-024
3.6.1.3	Nitrogen Interface MDP		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-12 & L-15	FD-025
3.6.1.4	Nitrogen Interface Temperature		A or T or A & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-026
3.6.2	Pressurized Gas Bottles	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-028
3.7.1.1	Pressure	Yes	A or T (PSRP)	A	A	A	A	N/A	A	N/A	L-8	Closed when hazard report app.
3.7.1.2	Temperature	Yes	A or T (PSRP)	A	A	A	A	N/A	A	N/A	L-8	Closed when hazard report app.
3.7.1.3	Humidity		A	A	A	A	A	N/A	A	N/A	L-8	EN-001
3.7.2.3.1.a - d	Spotlight Interface Requirements		D & I & T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-037
3.7.3.a, c, d, e	WV Environment		A or T or D	A	A	A	N/A	N/A	A	N/A	L-8	EN-007
3.7.4.1	Active Air Exchange		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EN-002
3.7.4.2	Oxygen Consumption		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EN-003
3.7.4.3	Chemical Releases	Yes	A & I (PSRP)	N/A	N/A	A	N/A	N/A	N/A	N/A	L-8	Closed when hazard report app.
3.7.4.4	Cabin Air Cooling		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EN-002

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Legend:

A – Analysis (when in verification method column), A – Applicable (when used in hardware column), D – Demonstrate, I – Inspection, N/A – Not Applicable
NVR – No verification required, PSRP – Payload Safety Review Panel, T – Test,

TABLE XXI PFMI VERIFICATION MATRIX

MSG IIRD Reqmt. No.	Requirement Statement	Safety	Verif. Method(s)	Thermal Chamber	Cables	Sample Ampoules	Stowage Boxes	Software	Cameras	PFMI Tool	Due Date	Remarks/ IIT VDS #
3.7.5.1	Investigation Contained or Generated Ionizing Radiation	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	Safety
3.8	Fire Protection Interface Requirements	Yes	A (PSRP)	A	N/A	N/A	N/A	N/A	A	N/A	L-8	Closed when hazard report app.
3.8.1.1.a - d	Investigation Fire Detection	Yes	T (PSRP)	N/A	N/A	N/A	N/A	A	N/A	N/A	L-8	Closed when hazard report app. Or CD-02 if applicable
3.8.1.2.a, b, c	Investigation Fire Suppression	Yes	A & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-055
3.9.1	Materials and Parts Use and Selection	Yes	A & I (PSRP)	A	A	A	A	N/A	A	A	L-8	Closed when hazard report app.
3.9.1.1	Commercial Parts	Yes	A & I (PSRP)	A	A	A	A	N/A	A	A	L-8	Closed when hazard report app.
3.9.1.2.a - f	Additional Material Requirements		A, I & T	A	A	A	A	N/A	A	A	L-8 & L-12 & L-20	FD-019, MP-003 (for f), MP-004
3.9.2	Cleanliness		I	A	A	A	A	N/A	A	A	L-8	MP-002
3.10.1.a, b, c	Strength Requirements		A or D	A	A	A	A	N/A	A	A	L-8	ST-005
3.10.2.1.1	Closures or Covers		I	A	A	A	A	N/A	A	N/A	L-8	ME-007
3.10.2.1.2.a	Built-In Control	Yes	I	N/A	N/A	A	N/A	N/A	N/A	N/A	L-8	ME-008
3.10.2.1.2.b	Built-In Control	Yes	A or D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-008
3.10.2.1.3	One-handed Operation		D	N/A	N/A	N/A	A	N/A	N/A	A	L-8	ME-009 Cleaning Supply Box only
3.10.2.2.1	Continuous/Incidental Contact-High Temperature	Yes	A (PSRP)	A	N/A	A	N/A	N/A	A	N/A	L-8	Closed when hazard report app.
3.10.2.2.2	Continuous/Incidental Contact-Low Temperature	Yes	A (PSRP)	A	N/A	A	N/A	N/A	A	N/A	L-8	Closed when hazard report app.
3.10.2.2.3.a	Acoustic Requirements	Yes	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	EN-006
3.10.2.2.3.b	Intermittent Noise Limits	Yes	T	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-10	EN-006
3.10.2.2.4	Lighting Design		D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-043

Legend:

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TABLE XXI PFMI VERIFICATION MATRIX

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3.10.3.1	Equipment Mounting		A or D	A	A	A	A	N/A	A	A	L-8	ME-011
3.10.3.2	Unique Tools		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-016
3.10.3.3	Connectors (Header)											
3.10.3.3.1	One-Handed Operation		A or D	A	A	A	N/A	N/A	A	N/A	L-8	ME-017
3.10.3.3.2	Connector Accessibility		A or D	A	A	A	N/A	N/A	A	N/A	L-8	ME-018
3.10.3.3.3	Connector Ease of Disconnect		A or D	A	A	A	N/A	N/A	A	N/A	L-8	ME-017
3.10.3.3.4	Connector Self Locking		A or D	A	A	A	N/A	N/A	A	N/A	L-8	ME-017
3.10.3.3.5	Connector Arrangement		I	A	A	A	N/A	N/A	A	N/A	L-8	ME-018
3.10.3.3.6	Connector Arc Containment	Yes	A	A	A	A	N/A	N/A	A	N/A	L-8	
3.10.3.3.7	Connector Protection	Yes	A	A	A	A	N/A	N/A	A	N/A	L-8	ME-019
3.10.3.3.8	Connector Shape		A	A	A	A	N/A	N/A	A	N/A	L-8	ME-019
3.10.3.3.9	Fluid and Gas Line Connectors	Yes	A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	FD-001
3.10.3.3.10	Connector Coding		A	A	A	A	N/A	N/A	A	N/A	L-8	ME-020
3.10.3.3.11	Connector Pin Identification		I	A	A	A	N/A	N/A	A	N/A	L-8	EL-007
3.10.3.3.12	Connector Orientation		A or D	A	A	A	N/A	N/A	A	N/A	L-8	ME-020
3.10.3.3.13	Alignment Marks or Guide Pins		I	A	A	A	N/A	N/A	A	N/A	L-8	ME-020
3.10.3.4	Fasteners (Header)											
3.10.3.4.1	Non-Threaded Fasteners Status Indication		D or I	N/A	N/A	A	N/A	N/A	N/A	N/A	L-8	ME-023
3.10.3.4.2	Mounting Bolt/Fastener Spacing		I	A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-024
3.10.3.4.3	Multiple Fasteners		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-025
3.10.3.4.4	Captive Fasteners		I	A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-026
3.10.3.4.5	Quick Release Fasteners		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-026
3.10.3.4.6	Threaded Fasteners		I	A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-026
3.10.3.4.7	Over Center Latches		I	N/A	N/A	N/A	A	N/A	N/A	N/A	L-8	ME-027
3.10.3.4.8	Winghead Fasteners		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-026
3.10.3.4.9	Fastener Head Type		I	A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-028
3.10.3.4.10	One-Handed Actuation		A or D	A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-029
3.10.3.4.12	Fastener Access Holes		I	A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-024

Legend:

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3.10.4	Controls and Displays (Header)											
3.10.4.1	Controls Spacing Design Requirements		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-030
3.10.4.2.a, b, c	Actuation Protective Methods		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-031
3.10.4.3	Controls Noninterference		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-030
3.10.4.4	Controls Barrier Guards		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-030
3.10.4.5	Recessed Switch Protection		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-031
3.10.4.6	Controls Position Indication		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-032
3.10.4.7	Hidden Controls		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-031
3.10.4.8	Hand Controllers		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-031
3.10.4.9.a - e	Valve Controls		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-033
3.10.4.10	Toggle Switches		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-034
3.10.5.1.a, b, c	Stowage Drawer Contents Restraints		A & I	N/A	N/A	N/A	A	N/A	N/A	N/A	L-8	ME-036
3.10.5.2.a & b	Stowage and Equipment Drawers/Trays		I	N/A	N/A	N/A	A	N/A	N/A	N/A	L-8	ME-027
3.10.5.3	Captive Parts		I	N/A	N/A	A	N/A	N/A	A	N/A	L-8	Only Items that can be removed from assemblies ME-036
3.10.5.4	Handles and Restraints		I or D	N/A	N/A	N/A	A	N/A	N/A	N/A	L-8	ME-037
3.10.5.5	Handle Location/Front Access		I	N/A	N/A	N/A	A	N/A	N/A	N/A	L-8	ME-037
3.10.5.6	Handle Dimensions		D & I	N/A	N/A	N/A	A	N/A	N/A	N/A	L-8	ME-037
3.10.7	Identification Labeling		I	A	A	A	A	N/A	A	A	L-8	ME-057
3.10.8.1.a	Crew Safety Electrical Hazards	Yes	NRV	A	A	N/A	N/A	N/A	N/A	N/A	L-8	EL-041
3.10.8.1.b	Crew Safety Electrical Hazards	Yes	A &/or T	A	A	N/A	N/A	N/A	N/A	N/A	L-8	EL-041
3.10.8.1.c	Crew Safety Electrical Hazards	Yes	A &/or T	A	A	N/A	N/A	N/A	N/A	N/A	L-8	EL-041
3.10.8.1.d	Crew Safety Electrical Hazards	Yes	A &/or T	A	A	N/A	N/A	N/A	N/A	N/A	L-8	EL-041

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TABLE XXI PFMI VERIFICATION MATRIX

MSG IIRD Reqmt. No.	Requirement Statement	Safety	Verif. Method(s)	Thermal Chamber	Cables	Sample Ampoules	Stowage Boxes	Software	Cameras	PFMI Tool	Due Date	Remarks/ IIT VDS #
3.10.8.1.e	Crew Safety Electrical Hazards	Yes	A &/or T	A	A	N/A	N/A	N/A	N/A	N/A	L-8	EL-041
3.10.8.2	Mismatched	Yes	A, I & D	A	A	A	N/A	N/A	A	N/A	L-8	ME-019
3.10.8.3.1	Device Accessibility		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-013
3.10.8.3.2	Extractor – Type Fuse Holder		D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-013
3.10.8.3.3	Overload Protection Location		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-013
3.10.8.3.4	Overload Protection Identification		I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-013
3.10.8.3.5	Automatic Restart Protection		D	A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	EL-013
3.10.8.4	Sharp Edges and Corners Protection	Yes	I (PSRP)	A	A	A	A	N/A	A	A	L-8	Closed when hazard report app.
3.10.8.4.1	Holes	Yes	A & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-007
3.10.8.4.2	Latches	Yes	I	N/A	N/A	N/A	A	N/A	N/A	N/A	L-8	ME-027
3.10.8.4.3	Screws and Bolts	Yes	A & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-026
3.10.8.4.4	Securing Pins	Yes	I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-053
3.10.8.4.5	Levers, Cranks, Hooks, and Controls	Yes	A & I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-053
3.10.8.4.6	Burrs	Yes	I	A	A	A	A	N/A	A	A	L-8	ME-053
3.10.8.4.7	Lockwire	Yes	A or I	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ST-009
3.10.9	Payload In-Flight Maintenance		A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	L-8	ME-003
3.10.11	Egress	Yes	(PSRP)	A	N/A	A	N/A	N/A	N/A	N/A	L-8	Closed when hazard report app.
3.11	Safety	Yes	(PSRP)	A	A	A	A	A	A	A	L-8	Closed when hazard reports app.
C.3.5.11	Bar Coding		I	A	A	A	A	A	A	A	L-8	ME-041

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ISSUE DATE JUL 20 2001

PAGE 1

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DOCUMENT INPUT RECORD

I. TO BE COMPLETED UPON SUBMITTAL OF DATA

1. APPROVED PROJECT: <i>MS-II</i>	2. DOCUMENT/ DRAWING NO.: <i>MSFC-ICD-3085 DPRS# 9537</i>	3. CONTROL NUMBER: <i>MSFC-ICD-3085A</i>	4. DOCUMENT RELEASE DATE: <i>7-20-01</i>	5. SUBMITTAL DATE: <i>7-20-01</i>
6. DOCUMENT/DRAWING TITLE: <i>MS-II ICD for O7MI, MSFC-ICD-3085A Doc</i>		7. REPORT TYPE: <i>SD 46</i>		
8. CONTRACT NO./PERFORMING ACTIVITY: <i>101-51-10</i>	9. DRD NUMBER: <i>N/A</i>	10. DPD / DRL / IDRD NUMBER: <i>N/A</i>		
11. DISPOSITION AUTHORITY (official records only): <i>SD 46</i>	12. SUBMITTAL AUTHORITY: <i>SD 46</i>	13. RELEASING AUTHORITY: <i>SD 46</i>		
14. SPECIAL INSTRUCTIONS: <i>None</i>				
15. CONTRACTOR/SUBMITTING ORGANIZATION, ADDRESS AND PHONE NUMBER: <i>MSFC</i>		16. ORIGINATING NASA CENTER: <i>MSFC</i>		
17. OFFICE OF PRIMARY RESPONSIBILITY: <i>SD 46</i>				
18. KEYWORDS: <i>MS-II, O7MI, ICD</i>		19. NUMBER OF PAGES: <i>56</i>	20. SECURITY CLASSIFICATION OF REPORT: <i>unclassified</i>	

II. TO BE COMPLETED FOR ENGINEERING DRAWINGS

21. REVISION:	22. ENG. ORDER:	23. PARTS LIST:	24. CCBD:
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III. TO BE COMPLETED FOR REPORTS, SPECIFICATIONS, ETC.

25. REVISION: <i>A</i>	26. CHANGE: <i>(P)</i>	27. VOLUME:	28. BOOK:	29. PART:	30. SECTION:
31. ISSUE:	32. ANNEX:	33. SCN:	34. DCN: <i>IRN-001</i>	35. AMENDMENT: <i>CB</i> <i>IRN-001 CB</i>	
36. APPENDIX:	37. ADDENDUM:	38. CCBD:	39. CODE ID:	40. IRN:	

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41. NAME: <i>Donnie McCaghren</i>	42. SIGNATURE: <i>Donnie McCaghren</i>	43. ORG. CODE: <i>SD46</i>	44. PHONE NUMBER: <i>544-9361</i>	45. DATE: <i>6/4/01</i>
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46. RECEIVED BY: <i>Debra Muhammad</i>	47. DATE RECEIVED: <i>7-20-01</i>	48. WORK ORDER: <i>02-00813</i>
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